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**गुणवत्ता आश्वासन के लिए इस्पात ढलाइयों के  
वर्गीकरण के नियम**  
( दूसरा पुनरीक्षण )

**Norms for Classification of Steel  
Foundries for Quality Assurance**  
( Second Revision )

ICS 77.140.80

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**भारतीय मानक ब्यूरो**  
**BUREAU OF INDIAN STANDARDS**  
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली - 110002  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI - 110002  
[www.bis.gov.in](http://www.bis.gov.in) [www.standardsbis.in](http://www.standardsbis.in)

## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the after the draft finalized by the Foundry and Steel Casting Sectional Committee and approval of Metallurgical Engineering Division Council.

This standard was first published in 1987 and subsequently revise in 1996. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards. It also incorporates amendment 1 which is under wide circulation.

In addition, the following changes have been made:

- a) Reference clause is modified; and
- b) Substitution of 'infrared pyrometer or optical pyrometer' for 'optical pyrometer' in all possible clauses.

For a long time, a need has been felt by many organizations involved in the purchase of steel castings, to have an Indian Standard giving an objective basis for classifying the competing foundries based on their level of quality assurance and reliability. This would facilitate evaluation of bids, selection of supplier of appropriate reliability, fixation of differential purchase prices wherever found desirable, etc. This standard is also intended to make the manufacturers aware of the requirements they have to fullfil to meet the specified quality assurance rating. Thus, it is expected that this standard would meet the very important national requirement of establishing an objective basis for classification and rating of steel foundries in the country, from the quality point of view.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 'Rules for rounding off numerical values (*second revision*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# NORMS FOR CLASSIFICATION OF STEEL FOUNDRIES FOR QUALITY ASSURANCE

*( Second Revision )***1 SCOPE**

This standard covers the norms for classification of steel foundries based on their compliance with the requirements for quality assurance including personnel and equipment.

**2 REFERENCES**

The standards given below contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards:

<i>IS No.</i>	<i>Title</i>
IS 2595 : 2008	Industrial radiographic testing — Code of practice ( <i>second revision</i> )
IS 9565 : 1995	Acceptance standards for ultrasonic inspection of steel castings — Specification ( <i>second revision</i> )
IS 10724 : 2023	Acceptance standards for magnetic particle inspection of steel castings — Specification ( <i>second revision</i> )
IS 11732 : 1995	Acceptance standards for liquid penetrant inspection of steel casting ( <i>first revision</i> )
IS 12938 : 1990	Acceptance standards for radiographic inspection of steel castings

**3 TERMINOLOGY**

Except where specifically defined at the respective places, the terms used herein convey the meaning normally understood in the trade.

**4 CLASSIFICATION OF STEEL FOUNDRIES**

**4.1** There shall be two classes of steel foundries based on their levels of quality assurance, namely, Class A and Class B.

**4.2** To qualify Class A or Class B a foundry shall conform to the pre-requisites in **5** and further comply with the particular requirements given in **6**, to the extent specified in **4.4**.

**4.3** In **6**, the requirements for each class are defined as either 'Vital' (indicated by 'V'), 'Essential' (indicated by 'E'), or 'Desirable' (indicated by 'D'). In the process of evaluation, against each requirement, 'Yes' or 'No' or 'NA' (Not Applicable) is to be filled. In some cases, where there is a temporary non-compliance with a particular requirement for a short duration only, then 'C Yes' (for Conditional Yes) may be filled (*see 4.4.1, 4.4.1.1 and the Notes under 4.4.1.1*).

**4.4** To qualify for a given class, a foundry must get 'Yes' or 'NA' against at least 92 percent of the 'Essential' requirements and against at least 80 percent of the 'Desirable' requirements stipulated in **6** for that class. Further, all the 'Vital' requirements contained in the following clauses must be complied with, without any exception:

**6.2.7, 6.2.8, 6.2.10, 6.3.2, 6.3.3, 6.4.3, 6.4.6.1, 6.4.8, 6.5.12, 6.5.21, 6.5.22, 6.6.2, 6.6.3, 6.6.6, 6.6.10, 6.6.11, 6.7.5, 6.7.6, 6.7.7, 6.7.9, 6.7.10, 6.8.1, 6.8.3, 6.8.14, 6.9.1, 6.9.3, 6.9.4 and 6.9.11.**

It may be noted that the number of 'Vital', 'Essential' and 'Desirable' requirements stipulated for Class A are 48, 85 and 9 and for Class B are 40, 62 and 48 respectively.

**4.4.1** If there is a 'Conditional Yes' against any requirement due to a purely temporary noncompliance, then the same may be deemed to be 'Yes' provided both the following conditions are fulfilled and subject to Note 2 under **4.4.1.1**:

- The total duration of non-compliance does not exceed, or is not likely to exceed, 60 days in case of an 'Essential' requirements and does not exceed, or is not likely to exceed, 90 days in case of a 'Desirable' requirements; and
- The number of such 'Conditional Yes' entries does not exceed 1 in 'Essential' items and 2 in 'Desirable' items

**4.4.1.1** Where the requirements given in **4.4.1(a)** is met but the number of such entries, exceeds the

limit given in **4.4.1(b)**, then, provided that such entries are not over 2 in 'Essential' and 5 in 'Desirable' items, the foundry shall be eligible to qualify for the relevant class on a PROVISIONAL basis and the word PROVISIONAL shall suffix the class, namely:

Class A (PROVISIONAL VALID UP TO .....)

or

Class B (PROVISIONAL VALID UP TO .....)

#### NOTES

**1** The representation shown above is further subject to additional suffixing specified in **4.5**, **4.5.2** and **4.6**.

**2** The above relaxations contained in **4.4.1** and **4.4.1.1** do not apply to any of the requirements which are deemed to be 'Vital' (*see* **4.4**) and non-compliance with any of the specified 'Vital' requirements even temporarily would call for a 'No' and not 'C Yes'.

**3** Any temporary non-compliance that does not satisfy the stipulation in **4.4.1(a)** shall be treated as a 'NO'.

**4.4.1.2** On overcoming the temporary non-compliance, when the foundry qualifies to a class subsequently, the suffix PROVISIONAL may be deleted.

**4.5** A foundry, by its own evaluation, on being satisfied that it fulfils the requirements of a certain class, may claim that class. In such a case, it may represent its own rating as:

CLASS A, CLAIMED

or

CLASS B, CLAIMED

**4.5.1** When a class is claimed by a foundry, the concerned purchaser will have a right of access to the foundry to verify the claim.

**4.5.2** On the other hand, when a foundry is surveyed by a competent outside organization and is accorded a class, then the foundry may represent its rating as having been CERTIFIED, but must also name the certifying outside organization, namely:

Class A, CERTIFIED (Certified by M/s PQR Ltd,  
VALID UP TO .....)

or

Class B, CERTIFIED (Certified by M/s XYZ Ltd,  
VALID UP TO .....)

**4.6** It is open to a manufacturer and purchaser to agree on some variations in the norms stipulated in this standard while broadly conforming to its philosophy and methodology. When classification of a foundry is done and certified by the purchaser's representative under this standard but with some

altered norms, then in representing the class, it must be brought out that the classification was done SPECIFIC to the needs of that purchaser, namely:

Class A, SPECIFIC (Certified by M/s DEF Ltd, to  
their SPECIFIC NEEDS, VALID UP TO.....)

or

Class B, SPECIFIC (Certified by M/s XYZ Ltd, to  
their SPECIFIC NEEDS, VALID UP TO .....)

**4.6.1** To avoid a misleading impression, the classification mentioned in **4.6** shall not be used if the alterations in the classification norms with respect to this standard are extensive or are sharply different in key aspects or involve disregarding any 'Vital' requirement (*see* **4.4**). When called upon by a different concerned buyer, the foundry shall supply the details of the variations in securing the SPECIFIC rating.

**4.7** When requested by a concerned purchaser, the details of the survey and the basis of the classification done by the certifying agency shall be furnished by the foundry.

#### 4.8 Validity Period of Classification

**4.8.1** A classification once given following a survey would be initially valid for a period of one year only. On securing a certain class consecutively for two years thus, thereafter, a classification of the same level given on the third occasion will have a validity of two years instead of the earlier two periods of validity of one year each. In exceptional cases, where the same outside organization is surveying the foundry for the third time or thereafter, and is satisfied with the consistency of the quality assurance set-up in the foundry, it may grant a period of validity of three years, instead of two years, for the classification given.

**4.8.2** If during the period of validity of certification given, any substantial change takes place which was a bearing on shifting classification from one class to another or takes the foundry below the minimum requirements under CLASS B, then it shall be the responsibility of the foundry to inform the certifying agency accordingly. So also where applicable the classification may be changed from 'CERTIFIED' to 'PROVISIONAL'.

#### 5 PRE-REQUISITES

##### 5.1 Quality Assurance Manuals

The foundry shall have written quality assurance manual and system of documents to enable objective verification of compliance with it and also requirements specified in **6**.

## 5.2 Organization

The foundry has a senior level person, free from all production responsibilities, and preferably independent of all other functions, who is responsible for quality assurance matters. He reports not to the person directly incharge of production, but will be functionally parallel to him, though not necessary of the same level. He has the necessary authority and freedom to discharge the responsibility satisfactorily.

The purpose of the above stipulation is that there is one person who acts as a focal point on behalf of the top management to co-ordinate and monitor the quality system and to intervene and to ensure correction of any deviations by timely action by the concerned departments.

## 6 PARTICULAR REQUIREMENTS

**6.1** Given under this clause are the requirements to be fulfilled area wise, quantified to the extent reasonably feasible without making them irrelevantly rigid. It is recognized that in certain exceptional cases, a requirement stipulated may not really be applicable in view of the special circumstances prevailing in that foundry. In such a situation, the person surveying and rating the foundry may use his discretion to mark 'NA' (for Not Applicable) against that requirement. It is expected that in reality there will be very few such cases of exception (*see 4.3*).

Tabulated below are the requirements stipulated for each class for various areas. Under the column 'Requirement for' the letter 'V' stands for 'Vital', 'E' stands for 'Essential' (*see 4.4*) and the letter 'D' stands for 'Desirable':

Aspect	Requirement for	
	Class A	Class B
<b>6.2 General</b>		
<b>6.2.1</b> The foundry has a formal employee performance review system, wherein the quality of work is one of the important parameters.	E	D
<b>6.2.3</b> A training plan is drawn up periodically, at an interval of not more than one year, covering identified training needs.	E	E
<b>6.2.3</b> A training plan is drawn up periodically, at an interval of not more than one year,	E	E
covering identified training needs.		
<b>6.2.4</b> The training plan is effectively implemented and reviewed.	E	E
<b>6.2.5</b> Laid down guidelines exist concerning the recruitment of employees with special reference to the requirements of qualification and experience for each relevant post and the same are generally adhered to.	D	D
<b>6.2.6</b> The foundry has an in-house research and development facility recognized by the Government of India.	E	D
<b>6.2.7</b> If <b>6.2.6</b> is not complied with, then the foundry has an in-house captive research and development facility, substantially separate from the normal line facilities and personnel, but not recognized by the Government of India.	V	V
<b>6.2.8</b> A list of approved vendors or sub-contractors exists for all the important foundry inputs and the same is periodically updated.	V	E
<b>6.2.9</b> There are comprehensive specifications for all the important bought-out materials.	E	D
<b>6.2.10</b> There is an operating system of the important incoming materials and inputs being inspected and cleared prior to their issue to the floor and the authority for clearing such materials is defined and the results of such inspection are documented.	V	V
<b>6.2.11</b> Forums exist involving different levels of employees, including preferably the lowest levels, for reviewing periodically the quality status in the foundry in different sections.	E	D

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
<b>6.3 Process Engineering (Method)/Patterns</b>			<b>6.3.4</b> Documentation exists whereby the drawing dimensions, the expected pattern dimensions, the actual pattern dimensions and the actual casting dimensions can be compared, at least for the sample or pilot castings.	E	E
<b>6.3.1</b> There is a person with formal post graduate qualifications in foundry engineering or equivalent, working exclusively of predominantly in this area.	D	D	<b>6.3.5</b> A procedure exists providing for decision making and written instructions concerning corrective actions to be taken against deviations in dimensions and quality, after the sample or pilot casting is made and the implementation of such instructions is also recorded.	E	D
<b>6.3.2</b> If <b>6.3.1</b> is not complied with, then there is a person working exclusively in this area satisfying the following requirement:			<b>6.3.6</b> Each new pattern, and each repeat pattern that has undergone repair, is inspected prior to being released for further processing and the observations are recorded.	E	E
a) At least a bachelor's degree in mechanical/metallurgical/foundry engineering, and having not less than 5 years relevant experience; or	V	D	<b>6.3.6.1</b> Such a pattern inspection is carried out by a person who has no production responsibility.	E	D
b) A diploma in mechanical/metallurgical/foundry engineering with at least 10 years relevant experience.	—	V	<b>6.3.6.2</b> The patterns are stored safely and in an orderly fashion with reasonable ease of retrieval.	E	E
<b>6.3.3</b> For each job (concerning each pattern number), the following exist duly documented:			<b>6.3.7</b> A system exists to enable the different shops to record their observations concerning the quality aspects and other problems encountered in dealing with a sample or pilot casting, for each job.	E	D
a) Pattern design;	V	V	<b>6.3.8</b> A system of intermediate or stage sampling exists to facilitate investigation and ensuring compliance with the required dimensions and quality during bulk production, especially in case of long run items.	E	E
b) Gating and riser design;	V	V	<b>6.3.9</b> There is a forum for discussion and debate concerning the pattern design	E	D
c) Moulding materials and methods;	V	V			
d) Pouring temperature;	V	D			
e) Heat treatment cycle;	V	E			
f) Applicable test piece, where relevant;	V	V			
g) Casting identification; and	V	V			
h) Special instructions, where relevant, concerning shakeout, gas cutting, welding procedure, etc.	V	D			

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
and process engineering of at least the more difficult items, involving concerned shop floor personnel.			<b>6.4.2</b> An infrared pyrometer or optical pyrometer exists for measuring temperature of liquid metal, especially during pouring.	E	E
<b>6.3.10</b> This section has information periodically supplied in writing, concerning the problems, if any, encountered in the course of bulk production of an item to enable review and corrective action.	E	D	<b>6.4.3</b> Temperature of the liquid metal is actually measured before tapping and is recorded for each melt.	V	V
<b>6.3.11</b> system exists for recording, preferably before an action or immediately thereafter, any changes made in process engineering, including pattern, gating and rise ring, etc and such a record forms a part of the technical documentation in the process engineering section for each job.	E	E	<b>6.4.4</b> The temperature measuring equipment is calibrated at least:		
			a) Once a month or more often; and	D	—
			b) Once in three months or more often.	E	E
<b>6.3.12</b> For each job, a consolidated history of rejection together with the causes is readily available in the process engineering section soon after the completion of the execution of the job.	E	E	<b>6.4.5</b> The target range of chemical composition is prescribed in advance of the start of each melt.	E	E
<b>6.3.12.1</b> System exists for recording, preferably before an action or immediately thereafter, any changes made in process engineering, including pattern, gating and rise ring, etc and such a record forms a part of the technical documentation in the process engineering section for each job.	E	E	<b>6.4.6</b> Each melt is analysed and ensured to be in compliance with the specification before tapping.	E	D
<b>6.3.12.2</b> For each job, a consolidated history of rejection together with the causes is readily available in the process engineering section soon after the completion of the execution of the job.	E	E	<b>6.4.6.1</b> Even if a melt is tapped, the castings are isolated and held back till compliance as above is ensured.	V	V
<b>6.4 Melting</b>			<b>6.4.7</b> Cleanliness of metal from the point of view of inclusions is checked periodically and with a frequency of at least:		
<b>6.4.1</b> An immersion pyrometer exists for measuring temperature of liquid metal.	E	D	a) Once a week or more of often; and	E	D
			b) Once a month or more often.	—	E
			<b>6.4.8</b> The various kinds of scrap and foundry returns are kept duly identified and segregated, so as to avoid wrong charging or contamination.	V	V
			<b>6.4.9</b> Facilities exist for safe storage of all the relevant ferro alloys on the shop floor to avoid contamination, and in marked containers.	E	E

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
<b>6.4.10</b> Satisfactory facility exists for adequately preheating the ladle and other elements of the system which get in touch with liquid metal.	E	E	<b>6.5.6</b> A case of sodium silicate or 'no-bake' binder system, facilities exist and are used for impact penetration test on the moulds/cores.	E	D
<b>6.4.11</b> A system exists for documenting quantified details of sequential charging and additions for each melt.	E	E	<b>6.5.7</b> A system exists for periodic checking and recording of the conditions of the closing pins, match plate pins, mould box bushes and the mould box bush centre-to- centre distances.	E	E
<b>6.5 Casting</b>					
<b>6.5.1</b> Separate personnel with adequate experience and competence exist who concentrate exclusively on process/quality control in each shift.	E	D	<b>6.5.8</b> Where separate risers of specified size are not supplied with each pattern, a system of standard size risers and their stocking with a satisfactory storage system exists.	E	E
<b>6.5.2</b> The composition and properties of different sand mixes are prescribed in writing.	E	E	<b>6.5.9</b> A practice exists for checking important dimensions while closing a mould in case of major jobs, at a reasonable frequency.	E	E
<b>6.5.3</b> The facing sand batches of each type are tested at a frequency whichever is higher of the alternatives given in subclauses (a) and (b) below:			<b>6.5.10</b> In such major jobs, where relevant, appropriate closing gauges are made use of.	D	D
a) Once a shift, or one in 5 batches; and	E	D	<b>6.5.11</b> A system exists for either checking of all moulds for their quality, their core setting and closing, etc or for checking a definite fraction of moulds of each category.	E	D
b) Once a shift, or one in 7 batches.	—	E			
<b>6.5.4</b> The baking sand batches of each type are tested at a frequency whichever is higher of the alternatives given in subclauses (a) and (b) below:			<b>6.5.12</b> The containers for measuring different additives to be put in, at the time of sand mixing are in good shape and are duly marked with the quantity of the contents they can accommodate. Alternatively, where the addition is automatic, a satisfactory programme with flexibility for re-set exists and is periodically calibrated.	V	V
a) Once a shift, or one in 5 batches; and	E	D			
b) Once a shift, or one in 7 batches.	—	E	<b>6.5.13</b> For each type of cores where core baking is involved, the baking cycle is pre-defined and documented.	E	E
<b>6.5.5</b> When the sand batches are tested, at least the following properties are checked and recorded:	E	E	<b>6.5.14</b> The core baking oven is fitted with at least a single point automatic continuous temperature recorder.	E	E
a) Green compression strength;					
b) Green shear strength;					
c) Moisture; and					
d) Permeability.					



Aspect	Requirement for	
	Class A	Class B
<b>6.5.15</b> The thermocouples, temperature recorders and indicators used in the baking oven are calibrated at a frequency of at least:		
a) Once in 6 months; and	D	—
b) Once in a year.	E	E
<b>6.5.16</b> The baking oven is surveyed to know the temperature variation between its different zones at a frequency of at least:		
a) Once in a year; and	E	D
b) Once in 2 years.	—	E
<b>6.5.17</b> The green properties of each type of core sand mix, including the green compression strength, green shear strength, permeability and moisture are tested at a frequency whichever is higher of the alternatives given in sub-clauses (a) and (b) below:		
a) Once a shift, or one in 4 batches; and	E	D
b) Once a shift, or one in 6 batches.	—	E
<b>6.5.18</b> The baked or hardened properties of each type of core sand mix, including compressive strength, shear strength, permeability and scratch hardness are tested at a frequency of at least once a day.	D	D
<b>6.5.19</b> At least in complex cores or in case of cores with a long run, the key dimensions are checked either directly or with gauges.	E	D
<b>6.5.20</b> Actual pouring temperatures of different melts are measured and recorded, using a suitable infrared, optical or any other pyrometer periodically calibrated as specified in <b>6.4.4</b> .	E	D
<b>6.5.21</b> A satisfactorily operating system of identifying each piece	V	V

Aspect	Requirement for	
	Class A	Class B
of casting, where relevant, so as to be able to trace it back to its melt number or heat-treatment batch number, exists.		
<b>6.5.22</b> The ratio of the strength of all workmen in the entire casting section (including areas of moulding, core making, sand mixing, shake-out, closing, pouring, material handling, etc) to the strength of the supervisory staff (including charge hands, if any) in section is:		
a) Less than 12; and	V	D
b) Less than 16.	—	V
<b>6.5.23</b> There is a method of ensuring a minimum time interval between pouring and shake-out as applicable to different weight ranges and specifications of items.	E	E
<b>6.6 Heat-Treatment</b>		
<b>6.6.1</b> Adequate capacity exists for in-house heat treatment of all the castings produced in the foundry, or in any case not less than 75 percent of the castings produced in the foundry.	E	E
<b>6.6.2</b> The heat-treatment furnaces are equipped with multipoint automatic continuous temperature recording arrangement, covering the different relevant furnace zones.	V	V
<b>6.6.3</b> Each of the heat-treatment furnaces has been calibrated using a sufficient number of thermocouples to know the prevailing temperatures in different zones at different temperature ranges.	V	E
<b>6.6.4</b> The permissible variation in the temperature at different zones is recorded and has been approved by the metallurgical/quality control section of the foundry to be acceptable for carrying out satisfactory heat-	E	E

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
treatment of the concerned alloys, based on a study of the effect on the properties of the castings due to such variations.			or by a particular buyer concerning high wall thickness castings or under any other special circumstances.		
<b>6.6.5</b> The charting of the temperature variations in the different zones of the furnace is done at an interval of:			<b>6.6.11</b> A heat-treatment batch of castings does not proceed to the next stage of processing unless cleared by the metallurgical/quality control section after ensuring attainment of the relevant mechanical properties.	V	V
a) Not more than one year; and	E	D	<b>6.6.12</b> In case of quenching facilities, arrangements exists for rapid transfer of castings from inside the furnace into the quenching medium so as to ensure that the time gap between the withdrawal of the castings from the furnace and their entry into the quenching medium is not over 60 s.	E	E
b) Not more than two year.	—	E	<b>6.6.13</b> Where liquid quenching is involved:		
<b>6.6.6</b> The thermocouples, temperature indicators and the recorders are calibrated at a frequency of at least once in 6 months.	V	V	a) In case of water medium, the capacity of the water tank is such that it can effectively accommodate water having a mass equal to or more than 5 times the mass of the total metallic charge (including the mass of the charging-tray, where relevant) which is quenched in the medium and also provides for sufficient clear space above the water level.	E	E
<b>6.6.7</b> In case of oil or gas fired furnace, there is a procedure for analysing the flue gases so as to keep a check on the percentage of free oxygen, which could have a deleterious effect on the casting surface.	E	D	b) In case of oil medium, the capacity of the oil tank is such that it can effectively accommodate oil having a mass equal to or more than 10 times the mass of the total metallic charge (including the mass of the charging tray, where relevant) which is quenched in	E	E
<b>6.6.8</b> The heat-treatment automatic recorder charts are subject to scrutiny and approval before the concerned batch of castings is released for further processing.	E	D			
<b>6.6.9</b> Such a scrutiny of heat-treatment charts is carried out by a representative of metallurgical/quality control section and not merely by the operating line staff and records kept for acceptance of heat treated lot.	E	D			
<b>6.6.10</b> Test bars accompany the relevant castings during heat-treatment, and the log sheet or other documents concerning each heat-treatment batch reflect the particulars of such test bars accompanying the batch.	V	V			

NOTE — An exception to the above requirement may be allowed where so permitted specifically by a National Standard

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
the medium, and also provides for sufficient clear space above the oil level.			<b>6.7.5</b> Shot blasting equipment exists which has a size and capacity commensurate with the type and quantity of the product range handled.	V	V
c) Arrangement exists to ensure that the temperature of the quenching medium before the plunging into the hot charge is not more than 10 °C above the ambient temperature or 45 °C whichever is higher.	E	E	<b>6.7.6</b> Written welding procedures, complete with the names of electrodes to be used, pre-weld and post-weld treatment, tests to be done where relevant, etc, exist.	V	V
d) There is some arrangement to create a sufficient amount of agitation of the quenching medium or sufficient relative movement between the charge and the medium during the process of quenching.	E	E	<b>6.7.7</b> The welding procedure is qualified at a frequency of at least once in two-years, in accordance with the relevant Indian Standards.	V	V
<b>6.7 Fettling</b>			<b>6.7.8</b> There are a sufficient number of welders qualified in accordance with Indian Standard or other agreed standards, to carry out quality repair/fabrication welding.	E	E
<b>6.7.1</b> Instructions exist concerning the stage, method and extent of removal of feeders, gates and their stubs for different grades of castings keeping in view the carbon equivalent, section thickness and other relevant considerations.	E	D	<b>6.7.9</b> Such welders are qualified at a frequency of not less than once in two years and there is documentary evidence to that effect subject to there being no break in continuity of welding exceeding 3 months.	V	V
<b>6.7.2</b> There are adequate number of DC welding machines.	E	E	<b>6.7.10</b> The authority to grant qualification to welding procedure and to welders is defined and is independent of the production section.	V	V
<b>6.7.3</b> There are arrangements for arc-air gouging or equivalent process for rapid metal removal with minimal input of heat into castings.	E	D	<b>6.7.11</b> Satisfactory arrangements in the form of thermos chucks, contact thermocouples, etc as may be appropriate, exist for measuring and monitoring the surface temperature in the course of welding.	E	E
<b>6.7.4</b> There are satisfactory dressing equipment commensurate with the kind of castings handled, including disc grinders for grooving and face grinding, pencil/die grinders, etc.	E	E	<b>6.7.12</b> Instructions exist restricting doing of any major weld repair on a casting without clear prior consent from the quality control staff.	E	E
			<b>6.7.13</b> A system exists for documenting the details of any	E	E

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
major weld repair done on a casting, where relevant.			thickness up to 150 mm, or for thickness as may be relevant for the product range handled in accordance with IS 12938.		
<b>6.7.14</b> Apart from the inspection/quality control staff, at least some personnel in the fettlings section have the training and competence to carry out the required surface inspection on the castings, like dye penetrant inspection and magnetic particle inspection.	E	D	<b>6.8.4</b> The inspection staff conducting the above non-destructive testing is adequately trained and qualified by a recognized agency and has adequate experience.	E	E
<b>6.8 Final Inspection</b>			<b>6.8.5</b> The relevant ASTM reference radiographs for classifying the radiographic quality levels exist to suit the source and the section thickness handled.	E	E
<b>6.8.1</b> The inspection/final quality control section has a graduate engineer with at least 5 years of relevant experience or a diploma holder with at least 10 years of relevant experience, working exclusively for inspection of the castings.	V	V	<b>6.8.6</b> Well defined guidelines exist concerning quality deviations for acceptance/rejection of castings.	E	E
<b>6.8.2</b> The number of staff in this section is adequate to carry out 100 percent inspection of the key parameters of all the castings, or in case of large quantity run items, of a statistically established percentage of castings.	E	E	<b>6.8.7</b> A daily rejection report of casting is prepared mentioning therein the cause of rejection against each casting.	E	D
<b>6.8.3</b> The following in-house facilities exist for carrying out the necessary inspection/testing:			<b>6.8.8</b> The authority for making rejection decisions is clearly defined and finally tests with the inspection/quality control section.	E	E
a) Liquid-penetrant inspection in accordance with IS 11732;	V	V	<b>6.8.9</b> Any castings decided to be rejected are promptly physically marked and isolated, so as to avoid any further processing or mix-up.	E	E
b) Magnetic particle inspection in accordance with IS 10724;	V	V	<b>6.8.10</b> The total weight of the castings received back from customers with a complaint, for any reason, during the previous two financial years does not exceed, as a percentage of the despatches made in those two previous financial years, the figures shown below:		
c) Ultrasonic examination in accordance with IS 9565 with facilities for quantifying the extent of a defect as in this Indian Standard and with the prescribed sensitivity of equipment; and	V	V	a) 2.0 Percent; and	—	E
d) Radiographic examination for section	V	V	b) 1.5 percent.	E	D

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
NOTES			ensure ready access within the section to such agreed terms.		
<p><b>1</b> Objective documents shall be available to verify the above.</p> <p><b>2</b> Where a foundry's production consists of more than 25 percent of its annual output being supplied against orders involving radiographic quality in accordance with IS 12938, magnetic particle inspection quality in accordance with IS 10724 or of liquid-penetrant inspection quality in accordance with IS 11732 or of ultrasonic inspection quality in accordance with IS 9565 or of equivalent standards, then the above permissible returns shall stand increased by further one percentage point.</p>			<p><b>6.8.15</b> Where any deviations are permitted from internal or agreed acceptance norms, the same are recorded.</p> <p><b>6.8.16</b> In case of machined castings, there is a record of the actual dimensions obtained after machining against each casting. (or alternatively, there are periodically calibrated check gauges for such machined dimensions and record of the dimensions maintained on the gauges and the details of their periodic calibration exist).</p>		
			<p><b>6.9 Metallurgical and Laboratory</b></p>		
<p><b>6.8.11</b> Casting check gauges and templates are used for controlling important dimensions which are not conveniently amenable for direct measurement, and also in case of large run item, where relevant.</p>			<p><b>6.9.1</b> The person incharge of the metallurgical area is at least a graduate metallurgical engineer with not less than 5 years of relevant experience.</p>		
<p><b>6.8.12</b> Separate standardized forms exist for recording the results of different kinds of non-destructive tests carried out, including a provision for indicating the deviations on a sketch of the relevant part of the castings.</p>			<p><b>6.9.2</b> The staff conducting tests like chemical analysis, sand testing, testing of mechanical properties, etc have adequate skill and competence and have undergone sufficient training to give them reasonable reliability.</p>		
<p><b>6.8.13</b> A practice exists for carrying out the appropriate type of non-destructive examination even on castings where the purchaser has not expressly called for such an examination, but such an examination is desirable to ensure freedom from defects thus assuring quality.</p>			<p><b>6.9.3</b> The skills of such staff are periodically qualified by making them carry out tests on blind samples, or by such other objective methods.</p>		
			<p><b>6.9.4 The Following Testing Facilities Exists:</b></p>		
			<p>a) Direct reading vacuum emission spectrometer, or any other equipment with at least equivalent speed and accuracy;</p>		
<p><b>6.8.14</b> The final inspection section gets a copy of all the technical terms agreed to with the purchaser and there is a system of recording such terms in appropriate inspection records, or there is a method to</p>			<p>b) Tensile testing equipment with a minimum of 20 tonnes of load capacity;</p>		

<i>Aspect</i>	<i>Requirement for</i>		<i>Aspect</i>	<i>Requirement for</i>	
	Class A	Class B		Class A	Class B
c) Impact testing facility for room temperature testing;	V	V	n) Sand shatter index testing equipment; and	V	D
d) Impact testing facility for sub-zero temperature testing up to - 45 °C;	V	E	p) Methylene blue test equipment for clay.	D	D
e) Fixed bench type or other heavy type equipments for carrying out hardness testing, that is BHN, HRC and VPN:			<b>6.9.5</b> Adequate standard samples are available for daily calibration of the method of chemical analysis followed.	E	E
1) At least one type; and	—	V	<b>6.9.6</b> The tensile equipment is calibrated at a frequency of at least once a year.	E	E
2) At least two type.	V	D	<b>6.9.7</b> The impact testing machine is calibrated at a frequency of at least once in 3 years.	E	D
f) Portable hardness tester of at least one type, other than poldi;	V	D	<b>6.9.8</b> Standard samples are available for calibrating the hardness testing equipment.	E	E
g) Micro-hardness tester;	D	D	<b>6.9.9</b> All the melts are tested for E chemical analysis and a method exists to recall/reject castings poured in a particular melt.	E	E
h) Shadowgraph or equivalent equipment for checking the correct notch shape and dimensions on the impact test specimen;	V	V	<b>6.9.10</b> All the heat-treatment batches are tested for the relevant mechanical properties.	E	E
j) Satisfactory photo-micrography equipment;	V	V	<b>6.9.11</b> All the test results are systematically recorded with reasonable ease of retrieval, so as to enable tracing back the history of any melt, heat-treatment batch or item.	V	V
k) Sand mouldability/compatibility testing equipment;	V	V	<b>6.9.12</b> The recent editions of all the relevant Indian Standard are readily available for reference.	E	E
m) Sand flowability testing equipment;	V	V			

**ANNEX A***(Foreword)***COMMITTEE COMPOSITION**

Foundry and Steel Castings Sectional Committee, MTD 14

<i>Organization</i>	<i>Representative(s)</i>
BHEL (CFFP), Haridwar	SHRI V. K. RAIZADA ( <b><i>Chairperson</i></b> )
Bharat Heavy Electricals Ltd, HPEP, Hyderabad	SHRI ABHINAV AGRAWAL
BHEL, Haridwar	SHRI A. N. SUDHAKAR SHRI RANJITH LAKRA ( <i>Alternate</i> )
Bhilai Engineering Corporation Limited, Bhilai	SHRI AKHIL DUBEY SHRI SHIV DUTT MISHRA ( <i>Alternate</i> )
CSIR - Central Mechanical Engineering Research Institute, Durgapur	DR SUDIP SAMANTHA
CSIR - National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram	DR TPD RAJAN DR M. RAVI ( <i>Alternate</i> )
Directorate General of Quality Assurance, Ichapur	SHRI ASHOK KUMAR SHRI S. ROY CHOWDHURY ( <i>Alternate</i> )
Disa India Ltd, Bangalore	SHRI SUNIL KUMAR GHOSH SHRI SURESH KUMAR A. ( <i>Alternate</i> )
Forace Polymers Private Limited, Haridwar	SHRI D. K. GHOSH
Hindustan Aeronautics, Foundry and Forge Division, Bengaluru	SHRI K. SATYENDRA KUMAR
Indian Institute of Technology, Kharagpur	PROF SHIV BRAT SINGH PROF RAHUL MITRA ( <i>Alternate</i> )
Indian Ordnance Factory Board, Kolkata	SHRI G. JHA SHRI A. K. LALA ( <i>Alternate</i> )
Indian Ordnance Factory, Grey Iron Foundry, Jabalpur	SHRI M. P. YADAV SHRI ARUNANSHU PRAMANIK ( <i>Alternate</i> )
Indian Register of Shipping, New Delhi	DR K. K. DHAWAN SHRI S. VELMURUGAN ( <i>Alternate</i> )
Institute of Technology (BHU), Varanasi	DR INDRAJIT CHAKRABARTY DR JAYANT KUMAR SINGH ( <i>Alternate</i> )
Leader Valves Ltd, Jalandhar	SHRIMATI PURNIMA BERI SHRI SARABJIT SINGH ( <i>Alternate</i> )
Ministry of Defence (DGQA), Ichapur	SHRI ASHOK KUMAR SHRI RUPESH BANAIT ( <i>Alternate</i> )
Ministry of Railway, RDSO, Lucknow	SHRI C. SENGUPTA SHRI RAJ KISHORE PRASAD ( <i>Alternate</i> )
Ministry of Science & Technology, New Delhi	MS TAMANNA ARORA SHRI K. S. P. RAO ( <i>Alternate</i> )

<i>Organization</i>	<i>Representative(s)</i>
National Institute of Foundry & Forging Technology, Ranchi	DR KAMLESH KUMAR SINGH DR AMITESH KUMAR ( <i>Alternate</i> )
National Metallurgical Laboratory, Jamshedpur	DR D. N. PASWAN MS MINAL SHAH ( <i>Alternate</i> )
NIT Manipur, Langol, Imphal	PROF (DR) GOUTAM SUTRADHAR DR ANIL KUMAR BIRRU ( <i>Alternate I</i> ) DR SABINDRA KACHHAP ( <i>Alternate II</i> )
Steel Cast Ltd, Bhavnagar	SHRI V. K. MODI SHRI B. C. ROUSTRAY ( <i>Alternate</i> )
Tata Motors, Jamshedpur	SHRI S. KUMAR DR D. S. PADAN ( <i>Alternate</i> )
The Institute of Indian Foundry Men, New Delhi	SHRI DINESH GUPTA SHRI SANJEEV KUMAR ( <i>Alternate</i> )
The Wesman Engineering Co Pvt Ltd, Kolkata	SHRI RANJAN GUHA SHRI ASHUTOSH MONDAL ( <i>Alternate I</i> ) SHRI PARTHA CHATTERJEE ( <i>Alternate II</i> )
Versatile Equipments Pvt Ltd, Kolhapur	SHRI PUSHKRAJ JANWADKAR SHRI KIRAN PANDI ( <i>Alternate</i> )
BIS Directorate General	SHRI SANJIV MAINI, SCIENTIST 'F'/SENIOR DIRECTOR AND HEAD (METALLURGICAL ENGINEERING) [REPRESENTING DIRECTOR GENERAL ( <i>Ex-officio</i> )]

*Member Secretary*  
SHRI KUNAL KUMAR  
SCIENTIST 'D'/JOINT DIRECTOR  
(METALLURGICAL ENGINEERING), BIS





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This Indian Standard has been developed from Doc No.: MTD 14 (21905).

### Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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### Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002  
Telephones: 2323 0131, 2323 3375, 2323 9402

Website: [www.bis.gov.in](http://www.bis.gov.in)

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Central : 601/A, Konnectus Tower -1, 6 <sup>th</sup> Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002	{ 2323 7617
Eastern : 8 <sup>th</sup> Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091	{ 2367 0012 2320 9474
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Email

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**Re: Request to seek approval for publishing Draft document IS 12117**

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**From :** raman sarita <raman.sarita@gmail.com>

Fri, Sep 22, 2023 03:08 PM

**Subject :** Re: Request to seek approval for publishing Draft document IS 12117**To :** MTD MTD <mtd@bis.gov.in>Approved  
RamanOn Fri, 22 Sept 2023, 10:54 MTD MTD, <[mtd@bis.gov.in](mailto:mtd@bis.gov.in)> wrote:

भारतीय मानक ब्यूरो  
(धातुकर्म अभियांत्रिकी विभाग)

दिनांक:-22.09.2023

**हमारा सन्दर्भ:-MTD14/ T-12**

Respected Sir,

You are requested to kindly approve the following drafts in accordance with sub-rule (5) of Rule 22 of Bureau of Indian Standards Rules, 2018. The drafts has been finalized by **Foundry and Steel Castings Sectional Committee, MTD 14** and Chairman after giving due consideration to the comments received from important Producers, Consumers, Technologists, Members of Metallurgical Engineering Division Council:

**1.MTD/14/21905 - NORMS FOR CLASSIFICATIONOF STEEL FOUNDRIES FOR QUALITY ASSURANCE (Second Revision)**

Copy of the draft document has been attached to this mail for kind information please.

Thanking You,

Sincerely,  
**Sanjiv Maini,**  
**Scientist-`F'/Senior Director & Head (MTD)**  
धातुकर्म इंजीनियरिंग विभाग/Metallurgical Engineering Department  
भारतीय मानक ब्यूरो/ Bureau of Indian Standards  
9, बहादुर शाह जफर मार्ग/9, Bahadur Shah Zafar Marg  
नई दिल्ली / New Delhi – 110002  
फोन/Phone: **011 23231085**  
ई-मेल/Email: **hmttd@bis.gov.in**  
मोबाइल/Mobile: **9818126659**



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वर्गीकरण के नियम  
( दूसरा पुनरीक्षण )

**Norms for Classification of Steel  
Foundries for Quality Assurance**  
( Second Revision )

ICS 77.140.80

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NEW DELHI - 110002  
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## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the after the draft finalized by the Foundry and Steel Casting Sectional Committee and approval of Metallurgical Engineering Division Council.

This standard was first published in 1987 and subsequently revise in 1996. This revision has been brought out to bring the standard in the latest style and format of the Indian Standards. It also incorporates amendment 1 which is under wide circulation.

In addition, the following changes have been made:

- a) Reference clause is modified; and
- b) Substitution of ‘infrared pyrometer or optical pyrometer’ for ‘optical pyrometer’ in all possible clauses.

For a long time, a need has been felt by many organizations involved in the purchase of steel castings, to have an Indian Standard giving an objective basis for classifying the competing foundries based on their level of quality assurance and reliability. This would facilitate evaluation of bids, selection of supplier of appropriate reliability, fixation of differential purchase prices wherever found desirable, etc. This standard is also intended to make the manufacturers aware of the requirements they have to fullfil to meet the specified quality assurance rating. Thus, it is expected that this standard would meet the very important national requirement of establishing an objective basis for classification and rating of steel foundries in the country, from the quality point of view.

The composition of the Committee responsible for the formulation of this standard is given in Annex A.

For the purpose of deciding whether particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# NORMS FOR CLASSIFICATION OF STEEL FOUNDRIES FOR QUALITY ASSURANCE

*( Second Revision )***1 SCOPE**

This standard covers the norms for classification of steel foundries based on their compliance with the requirements for quality assurance including personnel and equipment.

**2 REFERENCES**

The standards given below contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent edition of these standards:

<i>IS No.</i>	<i>Title</i>
IS 2595 : 2008	Industrial radiographic testing — Code of practice ( <i>second revision</i> )
IS 9565 : 1995	Acceptance standards for ultrasonic inspection of steel castings — Specification ( <i>second revision</i> )
IS 10724 : 2023	Acceptance standards for magnetic particle inspection of steel castings — Specification ( <i>second revision</i> )
IS 11732 : 1995	Acceptance standards for liquid penetrant inspection of steel casting ( <i>first revision</i> )
IS 12938 : 1990	Acceptance standards for radiographic inspection of steel castings

**3 TERMINOLOGY**

Except where specifically defined at the respective places, the terms used herein convey the meaning normally understood in the trade.

**4 CLASSIFICATION OF STEEL FOUNDRIES**

**4.1** There shall be two classes of steel foundries based on their levels of quality assurance, namely, Class A and Class B.

**4.2** To qualify Class A or Class B a foundry shall conform to the pre-requisites in **5** and further comply with the particular requirements given in **6**, to the extent specified in **4.4**.

**4.3** In **6**, the requirements for each class are defined as either 'Vital' (indicated by 'V'), 'Essential' (indicated by 'E'), or 'Desirable' (indicated by 'D'). In the process of evaluation, against each requirement, 'Yes' or 'No' or 'NA' (Not Applicable) is to be filled. In some cases, where there is a temporary non-compliance with a particular requirement for a short duration only, then 'C Yes' (for Conditional Yes) may be filled (*see 4.4.1, 4.4.1.1 and the Notes under 4.4.1.1*).

**4.4** To qualify for a given class, a foundry must get 'Yes' or 'NA' against at least 92 percent of the 'Essential' requirements and against at least 80 percent of the 'Desirable' requirements stipulated in **6** for that class. Further, all the 'Vital' requirements contained in the following clauses must be complied with, without any exception:

**6.2.7, 6.2.8, 6.2.10, 6.3.2, 6.3.3, 6.4.3, 6.4.6.1, 6.4.8, 6.5.12, 6.5.21, 6.5.22, 6.6.2, 6.6.3, 6.6.6, 6.6.10, 6.6.11, 6.7.5, 6.7.6, 6.7.7, 6.7.9, 6.7.10, 6.8.1, 6.8.3, 6.8.14, 6.9.1, 6.9.3, 6.9.4 and 6.9.11.**

It may be noted that the number of 'Vital', 'Essential' and 'Desirable' requirements stipulated for Class A are 48, 85 and 9 and for Class B are 40, 62 and 48 respectively.

**4.4.1** If there is a 'Conditional Yes' against any requirement due to a purely temporary noncompliance, then the same may be deemed to be 'Yes' provided both the following conditions are fulfilled and subject to Note 2 under **4.4.1.1**:

- a) The total duration of non-compliance does not exceed, or is not likely to exceed, 60 days in case of an 'Essential' requirements and does not exceed, or is not likely to exceed, 90 days in case of a 'Desirable' requirements; and
- b) The number of such 'Conditional Yes' entries does not exceed 1 in 'Essential' items and 2 in 'Desirable' items

**4.4.1.1** Where the requirements given in **4.4.1(a)** is met but the number of such entries, exceeds the

limit given in **4.4.1(b)**, then, provided that such entries are not over 2 in 'Essential' and 5 in 'Desirable' items, the foundry shall be eligible to qualify for the relevant class on a PROVISIONAL basis and the word PROVISIONAL shall suffix the class, namely:

Class A (PROVISIONAL VALID UP TO .....)

or

Class B (PROVISIONAL VALID UP TO .....)

#### NOTES

**1** The representation shown above is further subject to additional suffixing specified in **4.5**, **4.5.2** and **4.6**.

**2** The above relaxations contained in **4.4.1** and **4.4.1.1** do not apply to any of the requirements which are deemed to be 'Vital' (*see* **4.4**) and non-compliance with any of the specified 'Vital' requirements even temporarily would call for a 'No' and not 'C Yes'.

**3** Any temporary non-compliance that does not satisfy the stipulation in **4.4.1(a)** shall be treated as a 'NO'.

**4.4.1.2** On overcoming the temporary non-compliance, when the foundry qualifies to a class subsequently, the suffix PROVISIONAL may be deleted.

**4.5** A foundry, by its own evaluation, on being satisfied that it fulfils the requirements of a certain class, may claim that class. In such a case, it may represent its own rating as:

CLASS A, CLAIMED

or

CLASS B, CLAIMED

**4.5.1** When a class is claimed by a foundry, the concerned purchaser will have a right of access to the foundry to verify the claim.

**4.5.2** On the other hand, when a foundry is surveyed by a competent outside organization and is accorded a class, then the foundry may represent its rating as having been CERTIFIED, but must also name the certifying outside organization, namely:

Class A, CERTIFIED (Certified by M/s PQR Ltd,  
VALID UP TO .....)

or

Class B, CERTIFIED (Certified by M/s XYZ Ltd,  
VALID UP TO .....)

**4.6** It is open to a manufacturer and purchaser to agree on some variations in the norms stipulated in this standard while broadly conforming to its philosophy and methodology. When classification of a foundry is done and certified by the purchaser's representative under this standard but with some

altered norms, then in representing the class, it must be brought out that the classification was done SPECIFIC to the needs of that purchaser, namely:

Class A, SPECIFIC (Certified by M/s DEF Ltd, to  
their SPECIFIC NEEDS, VALID UP TO.....)

or

Class B, SPECIFIC (Certified by M/s XYZ Ltd, to  
their SPECIFIC NEEDS, VALID UP TO .....)

**4.6.1** To avoid a misleading impression, the classification mentioned in **4.6** shall not be used if the alterations in the classification norms with respect to this standard are extensive or are sharply different in key aspects or involve disregarding any 'Vital' requirement (*see* **4.4**). When called upon by a different concerned buyer, the foundry shall supply the details of the variations in securing the SPECIFIC rating.

**4.7** When requested by a concerned purchaser, the details of the survey and the basis of the classification done by the certifying agency shall be furnished by the foundry.

#### 4.8 Validity Period of Classification

**4.8.1** A classification once given following a survey would be initially valid for a period of one year only. On securing a certain class consecutively for two years thus, thereafter, a classification of the same level given on the third occasion will have a validity of two years instead of the earlier two periods of validity of one year each. In exceptional cases, where the same outside organization is surveying the foundry for the third time or thereafter, and is satisfied with the consistency of the quality assurance set-up in the foundry, it may grant a period of validity of three years, instead of two years, for the classification given.

**4.8.2** If during the period of validity of certification given, any substantial change takes place which was a bearing on shifting classification from one class to another or takes the foundry below the minimum requirements under CLASS B, then it shall be the responsibility of the foundry to inform the certifying agency accordingly. So also where applicable the classification may be changed from 'CERTIFIED' to 'PROVISIONAL'.

#### 5 PRE-REQUISITES

##### 5.1 Quality Assurance Manuals

The foundry shall have written quality assurance manual and system of documents to enable objective verification of compliance with it and also requirements specified in **6**.



## 5.2 Organization

The foundry has a senior level person, free from all production responsibilities, and preferably independent of all other functions, who is responsible for quality assurance matters. He reports not to the person directly incharge of production, but will be functionally parallel to him, though not necessary of the same level. He has the necessary authority and freedom to discharge the responsibility satisfactorily.

The purpose of the above stipulation is that there is one person who acts as a focal point on behalf of the top management to co-ordinate and monitor the quality system and to intervene and to ensure correction of any deviations by timely action by the concerned departments.

## 6 PARTICULAR REQUIREMENTS

**6.1** Given under this clause are the requirements to be fulfilled area wise, quantified to the extent reasonably feasible without making them irrelevantly rigid. It is recognized that in certain exceptional cases, a requirement stipulated may not really be applicable in view of the special circumstances prevailing in that foundry. In such a situation, the person surveying and rating the foundry may use his discretion to mark 'NA' (for Not Applicable) against that requirement. It is expected that in reality there will be very few such cases of exception (*see 4.3*).

Tabulated below are the requirements stipulated for each class for various areas. Under the column 'Requirement for' the letter 'V' stands for 'Vital', 'E' stands for 'Essential' (*see 4.4*) and the letter 'D' stands for 'Desirable':

Aspect	Requirement for	
	Class A	Class B
<b>6.2 General</b>		
<b>6.2.1</b> The foundry has a formal employee performance review system, wherein the quality of work is one of the important parameters.	E	D
<b>6.2.3</b> A training plan is drawn up periodically, at an interval of not more than one year, covering identified training needs.	E	E
<b>6.2.3</b> A training plan is drawn up periodically, at an interval of not more than one year,	E	E
covering identified training needs.		
<b>6.2.4</b> The training plan is effectively implemented and reviewed.	E	E
<b>6.2.5</b> Laid down guidelines exist concerning the recruitment of employees with special reference to the requirements of qualification and experience for each relevant post and the same are generally adhered to.	D	D
<b>6.2.6</b> The foundry has an in-house research and development facility recognized by the Government of India.	E	D
<b>6.2.7</b> If <b>6.2.6</b> is not complied with, then the foundry has an in-house captive research and development facility, substantially separate from the normal line facilities and personnel, but not recognized by the Government of India.	V	V
<b>6.2.8</b> A list of approved vendors or sub-contractors exists for all the important foundry inputs and the same is periodically updated.	V	E
<b>6.2.9</b> There are comprehensive specifications for all the important bought-out materials.	E	D
<b>6.2.10</b> There is an operating system of the important incoming materials and inputs being inspected and cleared prior to their issue to the floor and the authority for clearing such materials is defined and the results of such inspection are documented.	V	V
<b>6.2.11</b> Forums exist involving different levels of employees, including preferably the lowest levels, for reviewing periodically the quality status in the foundry in different sections.	E	D

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
<b>6.3 Process Engineering (Method)/Patterns</b>			<b>6.3.4</b> Documentation exists whereby the drawing dimensions, the expected pattern dimensions, the actual pattern dimensions and the actual casting dimensions can be compared, at least for the sample or pilot castings.	E	E
<b>6.3.1</b> There is a person with formal post graduate qualifications in foundry engineering or equivalent, working exclusively of predominantly in this area.	D	D	<b>6.3.5</b> A procedure exists providing for decision making and written instructions concerning corrective actions to be taken against deviations in dimensions and quality, after the sample or pilot casting is made and the implementation of such instructions is also recorded.	E	D
<b>6.3.2</b> If <b>6.3.1</b> is not complied with, then there is a person working exclusively in this area satisfying the following requirement:			<b>6.3.6</b> Each new pattern, and each repeat pattern that has undergone repair, is inspected prior to being released for further processing and the observations are recorded.	E	E
a) At least a bachelor's degree in mechanical/metallurgical/foundry engineering, and having not less than 5 years relevant experience; or	V	D	<b>6.3.6.1</b> Such a pattern inspection is carried out by a person who has no production responsibility.	E	D
b) A diploma in mechanical/metallurgical/foundry engineering with at least 10 years relevant experience.	—	V	<b>6.3.6.2</b> The patterns are stored safely and in an orderly fashion with reasonable ease of retrieval.	E	E
<b>6.3.3</b> For each job (concerning each pattern number), the following exist duly documented:			<b>6.3.7</b> A system exists to enable the different shops to record their observations concerning the quality aspects and other problems encountered in dealing with a sample or pilot casting, for each job.	E	D
a) Pattern design;	V	V	<b>6.3.8</b> A system of intermediate or stage sampling exists to facilitate investigation and ensuring compliance with the required dimensions and quality during bulk production, especially in case of long run items.	E	E
b) Gating and riser design;	V	V	<b>6.3.9</b> There is a forum for discussion and debate concerning the pattern design	E	D
c) Moulding materials and methods;	V	V			
d) Pouring temperature;	V	D			
e) Heat treatment cycle;	V	E			
f) Applicable test piece, where relevant;	V	V			
g) Casting identification; and	V	V			
h) Special instructions, where relevant, concerning shakeout, gas cutting, welding procedure, etc.	V	D			

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
and process engineering of at least the more difficult items, involving concerned shop floor personnel.			<b>6.4.2</b> An infrared pyrometer or optical pyrometer exists for measuring temperature of liquid metal, especially during pouring.	E	E
<b>6.3.10</b> This section has information periodically supplied in writing, concerning the problems, if any, encountered in the course of bulk production of an item to enable review and corrective action.	E	D	<b>6.4.3</b> Temperature of the liquid metal is actually measured before tapping and is recorded for each melt.	V	V
<b>6.3.11</b> system exists for recording, preferably before an action or immediately thereafter, any changes made in process engineering, including pattern, gating and rise ring, etc and such a record forms a part of the technical documentation in the process engineering section for each job.	E	E	<b>6.4.4</b> The temperature measuring equipment is calibrated at least:		
			a) Once a month or more often; and	D	—
			b) Once in three months or more often.	E	E
<b>6.3.12</b> For each job, a consolidated history of rejection together with the causes is readily available in the process engineering section soon after the completion of the execution of the job.	E	E	<b>6.4.5</b> The target range of chemical composition is prescribed in advance of the start of each melt.	E	E
<b>6.3.12.1</b> System exists for recording, preferably before an action or immediately thereafter, any changes made in process engineering, including pattern, gating and rise ring, etc and such a record forms a part of the technical documentation in the process engineering section for each job.	E	E	<b>6.4.6</b> Each melt is analysed and ensured to be in compliance with the specification before tapping.	E	D
<b>6.3.12.2</b> For each job, a consolidated history of rejection together with the causes is readily available in the process engineering section soon after the completion of the execution of the job.	E	E	<b>6.4.6.1</b> Even if a melt is tapped, the castings are isolated and held back till compliance as above is ensured.	V	V
<b>6.4 Melting</b>			<b>6.4.7</b> Cleanliness of metal from the point of view of inclusions is checked periodically and with a frequency of at least:		
<b>6.4.1</b> An immersion pyrometer exists for measuring temperature of liquid metal.	E	D	a) Once a week or more of often; and	E	D
			b) Once a month or more often.	—	E
			<b>6.4.8</b> The various kinds of scrap and foundry returns are kept duly identified and segregated, so as to avoid wrong charging or contamination.	V	V
			<b>6.4.9</b> Facilities exist for safe storage of all the relevant ferro alloys on the shop floor to avoid contamination, and in marked containers.	E	E

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
<b>6.4.10</b> Satisfactory facility exists for adequately preheating the ladle and other elements of the system which get in touch with liquid metal.	E	E	<b>6.5.6</b> A case of sodium silicate or 'no-bake' binder system, facilities exist and are used for impact penetration test on the moulds/cores.	E	D
<b>6.4.11</b> A system exists for documenting quantified details of sequential charging and additions for each melt.	E	E	<b>6.5.7</b> A system exists for periodic checking and recording of the conditions of the closing pins, match plate pins, mould box bushes and the mould box bush centre-to- centre distances.	E	E
<b>6.5 Casting</b>					
<b>6.5.1</b> Separate personnel with adequate experience and competence exist who concentrate exclusively on process/quality control in each shift.	E	D	<b>6.5.8</b> Where separate risers of specified size are not supplied with each pattern, a system of standard size risers and their stocking with a satisfactory storage system exists.	E	E
<b>6.5.2</b> The composition and properties of different sand mixes are prescribed in writing.	E	E	<b>6.5.9</b> A practice exists for checking important dimensions while closing a mould in case of major jobs, at a reasonable frequency.	E	E
<b>6.5.3</b> The facing sand batches of each type are tested at a frequency whichever is higher of the alternatives given in subclauses (a) and (b) below:			<b>6.5.10</b> In such major jobs, where relevant, appropriate closing gauges are made use of.	D	D
a) Once a shift, or one in 5 batches; and	E	D	<b>6.5.11</b> A system exists for either checking of all moulds for their quality, their core setting and closing, etc or for checking a definite fraction of moulds of each category.	E	D
b) Once a shift, or one in 7 batches.	—	E			
<b>6.5.4</b> The baking sand batches of each type are tested at a frequency whichever is higher of the alternatives given in subclauses (a) and (b) below:			<b>6.5.12</b> The containers for measuring different additives to be put in, at the time of sand mixing are in good shape and are duly marked with the quantity of the contents they can accommodate. Alternatively, where the addition is automatic, a satisfactory programme with flexibility for re-set exists and is periodically calibrated.	V	V
a) Once a shift, or one in 5 batches; and	E	D			
b) Once a shift, or one in 7 batches.	—	E	<b>6.5.13</b> For each type of cores where core baking is involved, the baking cycle is pre-defined and documented.	E	E
<b>6.5.5</b> When the sand batches are tested, at least the following properties are checked and recorded:	E	E	<b>6.5.14</b> The core baking oven is fitted with at least a single point automatic continuous temperature recorder.	E	E
a) Green compression strength;					
b) Green shear strength;					
c) Moisture; and					
d) Permeability.					

Aspect	Requirement for	
	Class A	Class B
<b>6.5.15</b> The thermocouples, temperature recorders and indicators used in the baking oven are calibrated at a frequency of at least:		
a) Once in 6 months; and	D	—
b) Once in a year.	E	E
<b>6.5.16</b> The baking oven is surveyed to know the temperature variation between its different zones at a frequency of at least:		
a) Once in a year; and	E	D
b) Once in 2 years.	—	E
<b>6.5.17</b> The green properties of each type of core sand mix, including the green compression strength, green shear strength, permeability and moisture are tested at a frequency whichever is higher of the alternatives given in sub-clauses (a) and (b) below:		
a) Once a shift, or one in 4 batches; and	E	D
b) Once a shift, or one in 6 batches.	—	E
<b>6.5.18</b> The baked or hardened properties of each type of core sand mix, including compressive strength, shear strength, permeability and scratch hardness are tested at a frequency of at least once a day.	D	D
<b>6.5.19</b> At least in complex cores or in case of cores with a long run, the key dimensions are checked either directly or with gauges.	E	D
<b>6.5.20</b> Actual pouring temperatures of different melts are measured and recorded, using a suitable infrared, optical or any other pyrometer periodically calibrated as specified in <b>6.4.4</b> .	E	D
<b>6.5.21</b> A satisfactorily operating system of identifying each piece	V	V

Aspect	Requirement for	
	Class A	Class B
of casting, where relevant, so as to be able to trace it back to its melt number or heat-treatment batch number, exists.		
<b>6.5.22</b> The ratio of the strength of all workmen in the entire casting section (including areas of moulding, core making, sand mixing, shake-out, closing, pouring, material handling, etc) to the strength of the supervisory staff (including charge hands, if any) in section is:		
a) Less than 12; and	V	D
b) Less than 16.	—	V
<b>6.5.23</b> There is a method of ensuring a minimum time interval between pouring and shake-out as applicable to different weight ranges and specifications of items.	E	E
<b>6.6 Heat-Treatment</b>		
<b>6.6.1</b> Adequate capacity exists for in-house heat treatment of all the castings produced in the foundry, or in any case not less than 75 percent of the castings produced in the foundry.	E	E
<b>6.6.2</b> The heat-treatment furnaces are equipped with multipoint automatic continuous temperature recording arrangement, covering the different relevant furnace zones.	V	V
<b>6.6.3</b> Each of the heat-treatment furnaces has been calibrated using a sufficient number of thermocouples to know the prevailing temperatures in different zones at different temperature ranges.	V	E
<b>6.6.4</b> The permissible variation in the temperature at different zones is recorded and has been approved by the metallurgical/quality control section of the foundry to be acceptable for carrying out satisfactory heat-	E	E

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
treatment of the concerned alloys, based on a study of the effect on the properties of the castings due to such variations.			or by a particular buyer concerning high wall thickness castings or under any other special circumstances.		
<b>6.6.5</b> The charting of the temperature variations in the different zones of the furnace is done at an interval of:			<b>6.6.11</b> A heat-treatment batch of castings does not proceed to the next stage of processing unless cleared by the metallurgical/quality control section after ensuring attainment of the relevant mechanical properties.	V	V
a) Not more than one year; and	E	D	<b>6.6.12</b> In case of quenching facilities, arrangements exists for rapid transfer of castings from inside the furnace into the quenching medium so as to ensure that the time gap between the withdrawal of the castings from the furnace and their entry into the quenching medium is not over 60 s.	E	E
b) Not more than two year.	—	E	<b>6.6.13</b> Where liquid quenching is involved:		
<b>6.6.6</b> The thermocouples, temperature indicators and the recorders are calibrated at a frequency of at least once in 6 months.	V	V	a) In case of water medium, the capacity of the water tank is such that it can effectively accommodate water having a mass equal to or more than 5 times the mass of the total metallic charge (including the mass of the charging-tray, where relevant) which is quenched in the medium and also provides for sufficient clear space above the water level.	E	E
<b>6.6.7</b> In case of oil or gas fired furnace, there is a procedure for analysing the flue gases so as to keep a check on the percentage of free oxygen, which could have a deleterious effect on the casting surface.	E	D	b) In case of oil medium, the capacity of the oil tank is such that it can effectively accommodate oil having a mass equal to or more than 10 times the mass of the total metallic charge (including the mass of the charging tray, where relevant) which is quenched in	E	E
<b>6.6.8</b> The heat-treatment automatic recorder charts are subject to scrutiny and approval before the concerned batch of castings is released for further processing.	E	D			
<b>6.6.9</b> Such a scrutiny of heat-treatment charts is carried out by a representative of metallurgical/quality control section and not merely by the operating line staff and records kept for acceptance of heat treated lot.	E	D			
<b>6.6.10</b> Test bars accompany the relevant castings during heat-treatment, and the log sheet or other documents concerning each heat-treatment batch reflect the particulars of such test bars accompanying the batch.	V	V			

NOTE — An exception to the above requirement may be allowed where so permitted specifically by a National Standard

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
the medium, and also provides for sufficient clear space above the oil level.			<b>6.7.5</b> Shot blasting equipment exists which has a size and capacity commensurate with the type and quantity of the product range handled.	V	V
c) Arrangement exists to ensure that the temperature of the quenching medium before the plunging into the hot charge is not more than 10 °C above the ambient temperature or 45 °C whichever is higher.	E	E	<b>6.7.6</b> Written welding procedures, complete with the names of electrodes to be used, pre-weld and post-weld treatment, tests to be done where relevant, etc, exist.	V	V
d) There is some arrangement to create a sufficient amount of agitation of the quenching medium or sufficient relative movement between the charge and the medium during the process of quenching.	E	E	<b>6.7.7</b> The welding procedure is qualified at a frequency of at least once in two-years, in accordance with the relevant Indian Standards.	V	V
<b>6.7 Fettling</b>			<b>6.7.8</b> There are a sufficient number of welders qualified in accordance with Indian Standard or other agreed standards, to carry out quality repair/fabrication welding.	E	E
<b>6.7.1</b> Instructions exist concerning the stage, method and extent of removal of feeders, gates and their stubs for different grades of castings keeping in view the carbon equivalent, section thickness and other relevant considerations.	E	D	<b>6.7.9</b> Such welders are qualified at a frequency of not less than once in two years and there is documentary evidence to that effect subject to there being no break in continuity of welding exceeding 3 months.	V	V
<b>6.7.2</b> There are adequate number of DC welding machines.	E	E	<b>6.7.10</b> The authority to grant qualification to welding procedure and to welders is defined and is independent of the production section.	V	V
<b>6.7.3</b> There are arrangements for arc-air gouging or equivalent process for rapid metal removal with minimal input of heat into castings.	E	D	<b>6.7.11</b> Satisfactory arrangements in the form of thermos chucks, contact thermocouples, etc as may be appropriate, exist for measuring and monitoring the surface temperature in the course of welding.	E	E
<b>6.7.4</b> There are satisfactory dressing equipment commensurate with the kind of castings handled, including disc grinders for grooving and face grinding, pencil/die grinders, etc.	E	E	<b>6.7.12</b> Instructions exist restricting doing of any major weld repair on a casting without clear prior consent from the quality control staff.	E	E
			<b>6.7.13</b> A system exists for documenting the details of any	E	E

Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
major weld repair done on a casting, where relevant.			thickness up to 150 mm, or for thickness as may be relevant for the product range handled in accordance with IS 12938.		
<b>6.7.14</b> Apart from the inspection/quality control staff, at least some personnel in the fettlings section have the training and competence to carry out the required surface inspection on the castings, like dye penetrant inspection and magnetic particle inspection.	E	D	<b>6.8.4</b> The inspection staff conducting the above non-destructive testing is adequately trained and qualified by a recognized agency and has adequate experience.	E	E
<b>6.8 Final Inspection</b>			<b>6.8.5</b> The relevant ASTM reference radiographs for classifying the radiographic quality levels exist to suit the source and the section thickness handled.	E	E
<b>6.8.1</b> The inspection/final quality control section has a graduate engineer with at least 5 years of relevant experience or a diploma holder with at least 10 years of relevant experience, working exclusively for inspection of the castings.	V	V	<b>6.8.6</b> Well defined guidelines exist concerning quality deviations for acceptance/rejection of castings.	E	E
<b>6.8.2</b> The number of staff in this section is adequate to carry out 100 percent inspection of the key parameters of all the castings, or in case of large quantity run items, of a statistically established percentage of castings.	E	E	<b>6.8.7</b> A daily rejection report of casting is prepared mentioning therein the cause of rejection against each casting.	E	D
<b>6.8.3</b> The following in-house facilities exist for carrying out the necessary inspection/testing:			<b>6.8.8</b> The authority for making rejection decisions is clearly defined and finally tests with the inspection/quality control section.	E	E
a) Liquid-penetrant inspection in accordance with IS 11732;	V	V	<b>6.8.9</b> Any castings decided to be rejected are promptly physically marked and isolated, so as to avoid any further processing or mix-up.	E	E
b) Magnetic particle inspection in accordance with IS 10724;	V	V	<b>6.8.10</b> The total weight of the castings received back from customers with a complaint, for any reason, during the previous two financial years does not exceed, as a percentage of the despatches made in those two previous financial years, the figures shown below:		
c) Ultrasonic examination in accordance with IS 9565 with facilities for quantifying the extent of a defect as in this Indian Standard and with the prescribed sensitivity of equipment; and	V	V	a) 2.0 Percent; and	—	E
d) Radiographic examination for section	V	V	b) 1.5 percent.	E	D



Aspect	Requirement for		Aspect	Requirement for	
	Class A	Class B		Class A	Class B
NOTES			ensure ready access within the section to such agreed terms.		
<p><b>1</b> Objective documents shall be available to verify the above.</p> <p><b>2</b> Where a foundry's production consists of more than 25 percent of its annual output being supplied against orders involving radiographic quality in accordance with IS 12938, magnetic particle inspection quality in accordance with IS 10724 or of liquid-penetrant inspection quality in accordance with IS 11732 or of ultrasonic inspection quality in accordance with IS 9565 or of equivalent standards, then the above permissible returns shall stand increased by further one percentage point.</p>			<p><b>6.8.15</b> Where any deviations are permitted from internal or agreed acceptance norms, the same are recorded.</p> <p><b>6.8.16</b> In case of machined castings, there is a record of the actual dimensions obtained after machining against each casting. (or alternatively, there are periodically calibrated check gauges for such machined dimensions and record of the dimensions maintained on the gauges and the details of their periodic calibration exist).</p>		
			<p><b>6.9 Metallurgical and Laboratory</b></p>		
<p><b>6.8.11</b> Casting check gauges and templates are used for controlling important dimensions which are not conveniently amenable for direct measurement, and also in case of large run item, where relevant.</p>			<p><b>6.9.1</b> The person incharge of the metallurgical area is at least a graduate metallurgical engineer with not less than 5 years of relevant experience.</p>		
<p><b>6.8.12</b> Separate standardized forms exist for recording the results of different kinds of non-destructive tests carried out, including a provision for indicating the deviations on a sketch of the relevant part of the castings.</p>			<p><b>6.9.2</b> The staff conducting tests like chemical analysis, sand testing, testing of mechanical properties, etc have adequate skill and competence and have undergone sufficient training to give them reasonable reliability.</p>		
<p><b>6.8.13</b> A practice exists for carrying out the appropriate type of non-destructive examination even on castings where the purchaser has not expressly called for such an examination, but such an examination is desirable to ensure freedom from defects thus assuring quality.</p>			<p><b>6.9.3</b> The skills of such staff are periodically qualified by making them carry out tests on blind samples, or by such other objective methods.</p>		
			<p><b>6.9.4 The Following Testing Facilities Exists:</b></p>		
			<p>a) Direct reading vacuum emission spectrometer, or any other equipment with at least equivalent speed and accuracy;</p>		
<p><b>6.8.14</b> The final inspection section gets a copy of all the technical terms agreed to with the purchaser and there is a system of recording such terms in appropriate inspection records, or there is a method to</p>			<p>b) Tensile testing equipment with a minimum of 20 tonnes of load capacity;</p>		

<i>Aspect</i>	<i>Requirement for</i>		<i>Aspect</i>	<i>Requirement for</i>	
	Class A	Class B		Class A	Class B
c) Impact testing facility for room temperature testing;	V	V	n) Sand shatter index testing equipment; and	V	D
d) Impact testing facility for sub-zero temperature testing up to - 45 °C;	V	E	p) Methylene blue test equipment for clay.	D	D
e) Fixed bench type or other heavy type equipments for carrying out hardness testing, that is BHN, HRC and VPN:			<b>6.9.5</b> Adequate standard samples are available for daily calibration of the method of chemical analysis followed.	E	E
1) At least one type; and	—	V	<b>6.9.6</b> The tensile equipment is calibrated at a frequency of at least once a year.	E	E
2) At least two type.	V	D	<b>6.9.7</b> The impact testing machine is calibrated at a frequency of at least once in 3 years.	E	D
f) Portable hardness tester of at least one type, other than poldi;	V	D	<b>6.9.8</b> Standard samples are available for calibrating the hardness testing equipment.	E	E
g) Micro-hardness tester;	D	D	<b>6.9.9</b> All the melts are tested for E chemical analysis and a method exists to recall/reject castings poured in a particular melt.	E	E
h) Shadowgraph or equivalent equipment for checking the correct notch shape and dimensions on the impact test specimen;	V	V	<b>6.9.10</b> All the heat-treatment batches are tested for the relevant mechanical properties.	E	E
j) Satisfactory photo-micrography equipment;	V	V	<b>6.9.11</b> All the test results are systematically recorded with reasonable ease of retrieval, so as to enable tracing back the history of any melt, heat-treatment batch or item.	V	V
k) Sand mouldability/compatibility testing equipment;	V	V	<b>6.9.12</b> The recent editions of all the relevant Indian Standard are readily available for reference.	E	E
m) Sand flowability testing equipment;	V	V			

**ANNEX A***(Foreword)***COMMITTEE COMPOSITION**

Foundry and Steel Castings Sectional Committee, MTD 14

<i>Organization</i>	<i>Representative(s)</i>
BHEL (CFFP), Haridwar	SHRI V. K. RAIZADA ( <b><i>Chairperson</i></b> )
Bharat Heavy Electricals Ltd, HPEP, Hyderabad	SHRI ABHINAV AGRAWAL
BHEL, Haridwar	SHRI A. N. SUDHAKAR SHRI RANJITH LAKRA ( <i>Alternate</i> )
Bhilai Engineering Corporation Limited, Bhilai	SHRI AKHIL DUBEY SHRI SHIV DUTT MISHRA ( <i>Alternate</i> )
CSIR - Central Mechanical Engineering Research Institute, Durgapur	DR SUDIP SAMANTHA
CSIR - National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram	DR TPD RAJAN DR M. RAVI ( <i>Alternate</i> )
Directorate General of Quality Assurance, Ichapur	SHRI ASHOK KUMAR SHRI S. ROY CHOWDHURY ( <i>Alternate</i> )
Disa India Ltd, Bangalore	SHRI SUNIL KUMAR GHOSH SHRI SURESH KUMAR A. ( <i>Alternate</i> )
Forace Polymers Private Limited, Haridwar	SHRI D. K. GHOSH
Hindustan Aeronautics, Foundry and Forge Division, Bengaluru	SHRI K. SATYENDRA KUMAR
Indian Institute of Technology, Kharagpur	PROF SHIV BRAT SINGH PROF RAHUL MITRA ( <i>Alternate</i> )
Indian Ordnance Factory Board, Kolkata	SHRI G. JHA SHRI A. K. LALA ( <i>Alternate</i> )
Indian Ordnance Factory, Grey Iron Foundry, Jabalpur	SHRI M. P. YADAV SHRI ARUNANSHU PRAMANIK ( <i>Alternate</i> )
Indian Register of Shipping, New Delhi	DR K. K. DHAWAN SHRI S. VELMURUGAN ( <i>Alternate</i> )
Institute of Technology (BHU), Varanasi	DR INDRAJIT CHAKRABARTY DR JAYANT KUMAR SINGH ( <i>Alternate</i> )
Leader Valves Ltd, Jalandhar	SHRIMATI PURNIMA BERI SHRI SARABJIT SINGH ( <i>Alternate</i> )
Ministry of Defence (DGQA), Ichapur	SHRI ASHOK KUMAR SHRI RUPESH BANAIT ( <i>Alternate</i> )
Ministry of Railway, RDSO, Lucknow	SHRI C. SENGUPTA SHRI RAJ KISHORE PRASAD ( <i>Alternate</i> )
Ministry of Science & Technology, New Delhi	MS TAMANNA ARORA SHRI K. S. P. RAO ( <i>Alternate</i> )

<i>Organization</i>	<i>Representative(s)</i>
National Institute of Foundry & Forging Technology, Ranchi	DR KAMLESH KUMAR SINGH DR AMITESH KUMAR ( <i>Alternate</i> )
National Metallurgical Laboratory, Jamshedpur	DR D. N. PASWAN MS MINAL SHAH ( <i>Alternate</i> )
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